Topic: Short term solar/atmospheric variability and climate

Project Title:
Response of the Atmosphere to Impulsive Solar Events (RAISE)

PI Name: Cora Randall
PI Email: randall@lasp.colorado.edu
Affiliation: University of Colorado
CO-I(s):
- Anthea J. Coster (MIT Haystack Observatory)
- Douglas Edward Kinnison (NCAR)
- Amir Caspi (University of Colorado, Boulder)
- V. Lynn Harvey (University of Colorado)
- Thomas N. Woods (University of Colorado)
- Liying Qian (UCAR)
- Charles H Jackman (NASA GSFC)
- Stanley C. Solomon (University Corporation for Atmospheric Research)
- Han-Li Liu (University Corporation for Atmospheric Research)

Collaborator(s):
- Annika Seppala (Finnish Meteorological Institute)
- Ulrike Langematz (Freie Universitaet Berlin)
- Hauke Schmidt (Max Planck Institute for Meteorology)
- Pekka T Verronen (Finnish Meteorological Institute)
- Bernd Funke (Instituto de Astrofísica de Andalucía (CSIC))
- Daniel Robert Marsh (National Center for Atmospheric Research)
- Miriam Sinnhuber (Karlsruhe Institute of Technology)
- Katja Bettina Matthes (GEOMAR Helmholtz Centre for Ocean Research Kiel)

Project Information:
The Response of the Atmosphere to Impulsive Solar Events (RAISE) Targeted Science Team will comprehensively address the Focused Science Topic Short term solar/atmospheric variability and climate. Our goal is to answer the broad question of how the Earth's atmosphere responds to impulsive solar events (ISEs). The proposed work has four primary objectives:

(1) How well do coupled chemistry climate models simulate effects of recent ISEs?

(2) What are the primary factors that control the atmospheric response to ISEs?

(3) What is the range and sensitivity of the atmospheric response to ISEs?

(4) Are there long-term, cumulative effects of ISEs on the atmosphere and climate, and with what certainty can these effects be modeled?

Solar energy input is a critical driver of the Earth's climate system, yet the climatic effects of ISEs are poorly understood. The key to improving our knowledge is unraveling the complex response of the atmosphere to ISEs, to clarify the mechanisms by which impulsive radiation and particle variations impact the atmosphere. RAISE is designed to address this challenge, and to explore implications for the climatological response of the Earth's atmosphere to ISEs. The focus of RAISE is variations in energetic particles and short-wavelength radiation that occur during ISEs. The bulk of this energy is initially absorbed in the upper atmosphere. Through dynamical and chemical processes the absorbed energy is redistributed, and its effects amplified through such mechanisms as catalytic cycles and nonlinear wave/mean-flow interactions. This coupling, and the extent to which it causes ISEs, either individually or cumulatively, to influence the atmosphere on time scales much longer than the ISE duration, are poorly understood.

RAISE will investigate these processes using measurements of high-energy solar particles and photons, comprehensive atmospheric models, observations of the atmosphere and ionosphere, and a team with the collective expertise to address the interdisciplinary aspects of this problem. The primary modeling tool is the Whole Atmosphere Community Climate Model (WACCM) under development at the National Center for Atmospheric Research (NCAR). This model will be driven with solar and magnetospheric inputs derived from space-based measurements, during quiet times and during ISEs, to investigate the physical mechanisms of ISE effects and their interaction with atmospheric dynamics. We will compare model simulation results with atmospheric observations from many space-based sources, and with ground-based observations of ionospheric changes. The measurement analyses will be performed for model validation and to explore the natural and event-driven components of variability. The interaction of atmospheric dynamics with chemical processes in the middle atmosphere will be investigated with ensemble model simulations and with runs constrained to observed meteorology. Ionospheric effects and changes in the global electrodynamo, driven by flare ionization as well as auroral processes, will be evaluated. Finally, we will ascertain through multiple ensemble simulations whether the model can produce any effects on stratospheric or even tropospheric climate, through episodic or cumulative forcing by ISEs.

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Citations: